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SUMMARY REPORT OF THE SCIENTIFIC ADVISORY BOARD SPACE TECHNOLOGY PANEL ON SPACE TECHNOLOGY

December 1960

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PREFACE

This report is submitted as a broad review of the major scientific and technical aspects of the Air Force Space Program. It does not represent a detailed consideration of the many specific areas included in space technology since such detailed review is the subject of continuing investigations by the other ten standing panels, as well as ad hoc committees of the Scientific Advisory Board.

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I. INTRODUCTION

During 1960 the Space Technology Panel of the Scientific Advisory Board considered several important aspects of the Air Force space program. In January the Panel was briefed by the Directorate of Development Planning, Headquarters USAF, its study contractor ANSER, and by Mr. Donovan of the Space Technology Laboratories. These briefings covered the entire scope of future space planning with an objective of delineating the key technical issues. In April the Panel was briefed by representatives of the AFBMD on the lunar exploration studies. In June the Panel was briefed by AFBMD and STL representatives on the "close-in" satellites, the preliminary studies of manned maintenances in space, and the broad complex of AICBM schemes. In October the Panel was briefed by representatives of ARPA, Hq USAF, ARDC and contractors on BAMBI, or SCWS, and also by Hq USAF, ANSER, AFCIN and WADD on defense against mobile missiles.

The Panel issued a report dated 29 April 1960 recommending that USAF present their lunar exploration studies to NASA and join NASA in a National program of lunar exploration.

The Panel issued a report in November on Space Counter Weapon Systems, and the Finding and Striking of Mobile Missiles. The Panel concluded that there is no current capability against mobile missiles on the ground, and that existing proposals appear to be lacking in technical feasibility and military effectiveness. It points out that target detection and discrimination are the most crucial areas required to determine the feasibility of strike reconnaissance systems. It recommended vigorous pursuit of sensor development and missile target signature experiments.

Space Counter Weapon Systems are considered to offer the greatest possibility for area defense, but SPAD and RBS are not considered to be effective examples of systems, and their development as systems is

not now favored. However, because of the long term promise of the general concept, a favorable view is taken of the vigorous prosecution of all phases of applicable experimentation, to include experiments from above the atmosphere and development and test of critical components.

In addition to these reports issued, the Panel gave verbal consultation on several of these briefings. They also have participated in the activity of the Ad Hoc Committee on Space Surveillance Sensors whose report was issued on August 15, 1960, and the Ad Hoc Committee on Aerospace Plane which is still acting.

In view of the above described widely varying activity of the Space Technology Panel it is considered desirable to issue a year-end report summarizing some of the Panel's ideas on the broad scope of the Air Force space activities.

II. GENERAL PHILOSOPHY

The Space Technology Panel is pleased to see the Air Force begin to crystalize a forward-looking and sensible military space program. Such a military space program is needed because of the changing balance of military capability between the U. S. and Russia; it is clearly feasible from the standpoint of science and technology to proceed to more advanced space systems.

Military space started with and has been principally concentrated in ballistic missilery. The Panel believes that this field of weaponry is reaching a point of diminishing returns as far as technological change is concerned, now that the spectrum of weapons includes Atlas and Titan, Thor and Jupiter, Polaris and Minuteman. Markedly smaller ICBMs than Minuteman, or larger than Atlas-Titan, seem to offer only slightly improved advantages. The biggest pay-off in these weapon systems will come by improved hardening, readiness, dispersal, mobility, etc., rather than by applications of advanced technology.

The newer aspects of a military space program are, in contrast to ballistic missilery, extremely sensitive to advancing technology, the surface of which, in our estimation, has only been scratched. The Air Force should insure that its program does advance the technology required for a military space program at the maximum rate.

In saying this, the Panel does not imply that specific military space missions beyond the ICBM are not sufficiently clear to be taken as specific goals. The maintenance of a favorable strategic balance demands the development of military communication satellites, military reconnaissance and mapping satellites, anti-ICBM early warning satellites. These are in the program. Equally clear military requirements which have somewhat less clear technical attainability are satellite interception vehicles, bombardment from satellites or recoverable satelloid ballistic missiles, and intercept during launch AICBMs. Nevertheless, technology is sufficiently advanced so that these systems can be postulated in some detail.

The ICBM is the cheapest strategic offensive weapon yet devised, and seems destined to become cheaper still with the introduction of the Minuteman system. For example, the direct cost of weapon delivery is of the order of one dollar per ton. The largest military and economic advantages of the ICBM, however, accrue to the aggressor who employs the techniques of surprise attack. The U. S., which must be prepared to receive the first blow, faces the serious problem of retaining an effective retaliatory force. Doing so requires dispersal and hardening of bases and maintenance of numbers of missiles in excess of that which would be destroyed in the first attack. For the U. S., a highly effective defense would constitute an important military advantage. Unfortunately in the present state of technology, no very effective earth-based system of ICBM defense seems to be attainable, and even systems of limited effectiveness which can be devised tend to be very costly to build.

The use of space-based weapon systems offers in the future to help to alleviate the precarious position of the defender. The Midas system, for instance, may provide a much more dependable (if system technical reliability requirements can be met) and timely warning of ballistic missile attack than is possible with BMEWS. The employment of a recallable ICBM may provide for our own ballistic missile force some of the same fail-safe capability as our manned bomber force now has. Some numbers of orbital bomber vehicles (capable of maneuver) may give the ballistic missile some of the same assurance or survival as the airborne alert gives to our manned bomber force. The recallable ICBM and the orbital bomber may themselves be manned or controlled from other manned space vehicles. Finally, an effective space-based and ballistic missile defense system capable of interception during launch may result from advances in space technology.

The Panel believes the following points:

1. There are certain technological problems which must be solved in order to make these new weapon developments both technically and economically feasible - these are outlined in Section III and may well be solved enroute in the development of specific weapon systems.

2. There are certain programs the Air Force must pursue to advance specific technology rather than to develop a focused military weapon system. These are discussed in Section IV.

3. The Space Electronic Environment for Defense is as essential as the vehicles which fly in space. This is discussed in Section V.

III. TECHNOLOGICAL PROBLEMS

A. Cheapness. It is essential to reduce sharply the cost of boosting payloads. In estimating the relative costs of various proposals, it is essential to remember that the military problem differs from the civilian one in that the military will want to boost much larger numbers of payloads of many diverse kinds.

Recoverable boosters should be carefully examined with this mass-production type of service in mind.

In general, we believe that small differences in estimated cost, up to a factor of 2 times, should be disregarded in making choices between competing proposals; at the other extreme, we believe differences of factors of 10 in estimated cost to be significant planning factors.

B. Reliability. The Problem: Satellites, such as might be used as part of an anti-ICBM system, will in all probability be limited in their useful life by the reliability of the components making up the payload. Speaking in very general terms, there are several different aspects of the problem. For example, for some components such as might be in the weapons carried by the anti-ICBM satellite, the principal requirement is for a long shelf-life but a comparatively short mean-time-to-failure. On the other hand, some components of a command system require the maximum attainable mean-time-to-failure. Obviously, it is this time which is directly related to the cost of maintaining a given number of operational units in orbit.

Components which have longest failure times are intended for use in quiet environments such as can indeed exist in an orbiting vehicle, but cannot withstand shock or high temperatures; they tend also to be large and/or heavy. They have primarily been developed for ground based data handling equipment such as general purpose digital computers.

But even such ground based heavy equipments require daily servicing if they are to operate continuously. In fact, we know of very few devices, such as clocks and telephone repeater amplifiers, which habitually function for years without attention. It is notable that these devices have required actual years as well as man-years for their development.

Solid state devices appear intrinsically most suited for such service as is contemplated. But the most advanced of these, those dependent upon doped single crystals of semi-conductors, are susceptible to radiation damage. Those not so susceptible, such as ordinary magnetic amplifiers, are also limited in their functional capability, and are relatively heavy.

One of the most expensive aspects of developing reliable equipment is demonstrating under actual environmental conditions that in fact reliability has been consistently achieved for the time period of interest. Unfortunately, in many cases, short time overload tests are not an acceptable short cut. In view of the long time periods involved in many military satellite applications, it is imperative that this program be accelerated.

In view of these considerations, the following ideas seem worthy of thought:

1. Component Reliability Test Satellite. This might carry a fixed program computer which continually multiplies two numbers and records how many mistakes it makes, this record being periodically radioed to earth. Real time must be used to find out what can be done mere hours are not the answer.

2. Use the minimum amount of equipment by:

a. Paring down the number of required functions:

2. Careful designing, using small integrated design teams such as in the Sidewinder Missile development.

3. Keeping most of the equipment turned off most of the time.

4. Developing a manned Minuteman capability for space seems imperative in the long run.

It is obvious that studies and programs for component reliability improvement, studies of the space environment, including the problem of radiation shielding and the like, which are now in train are all necessary and should continue to be supported.

IV. PROGRAMS TO ADVANCE SPECIFIC TECHNOLOGIES

Certainly the most important aspects of military space systems for the future are those dealing with man's capabilities in such systems related to the cost of making him part of the system. For the long term it is felt that the Air Force must study these capabilities of man, particularly in relation to the conduct of space warfare itself. Dyna Soar can be the Air Force program to do this if its objectives are kept oriented towards these problem areas.

The important point here is that the present Air Force programs both unmanned and manned can grow to develop the capabilities necessary for the conduct of space operations. The actual economic possibility of implementing these systems very well hinges on the reduction of launching costs by an order of magnitude through means discussed elsewhere. (Lower cost pressurized boosters, recovery, etc.).

The Panel suggests the following:

1. In-House capability for technology development with regard to manned military equipment should be supported. In the biological field (broadest sense) AF has the best facilities for support research directed toward manned machine. We wish to emphasize that biological tissue does not lend itself to "accelerated service testing". Hence it is imperative that studies and applied research needed to fill in gaps of needed information be expanded at once within existing AF facilities.

2. With regard to manned machines, it is imperative that "Limits of Human Tolerance" with regard to stress and performance be respected during design of hardware.

3. Known technology is available now to support man for periods up to about one week in space vehicles, without undue infringement on weight limitations. Suggest "short-time limitations" as opposed to "indefinite stay in space".

4. It is obvious that vehicles and devices will be orbited in "near" and "far" distances from earth. It is very conceivable that man's primary role in space will be that of inspection and maintenance of equipment in addition to surveillance and military maneuverability, offensive or defensive.

5. If lunar explorations are desirable from a military point of view, the <u>life support equipment</u> needed will be in essence no different for such an activity than that needed for "near" space orbiting unless the time element away from earth exceeds several weeks in which case "self-contained" ecology systems are needed.

6. With regard to the question of man's military function in space, either for his subsistence or to support his activities, concerted effort and support should be given to the possibility of what devices to be employed.

V. SPACE DEFENSE ELECTRONIC ENVIRONMENT

It must be recognized that the extent to which we will realize potential capabilities for using space-based weapons for offense and defense will depend in large measure on how well the capabilities for information gathering, processing, and control can be accomplished. This applies whether the system involved includes reconnaissance satellites, space interceptors, recallable orbital bombers or other space vehicles. The facilities to provide this essential capability have been called the <u>Space Defense Electronic Environment</u>. This environment will include ground based facilities, probably supplemented by communications satellites (or other orbiting devices - e.g., "Needles") and will have three primary functions:

A. Space surveillance

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B. Reception of data from cooperative space vehicles, and

C. Transmission of command and control signals.

The space surveillance function is particularly important and will provide continuous and accurate data on the disposition, orbits and characteristics of all man-made satellite objects, whatever nation put them up and whatever their purpose. It will be necessary to acquire the data rapidly and to up-date it frequently, especially for potentially threatening objects, in order to detect new launches, maneuvers or other changes in the space population.

An Ad Hoc Committee was established to examine various possible approaches to early solution of the space defense electronic environment problem. This report was issued August 1960.

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